

# The Russian Drought and Fires of 2010: An Overview using GEOS-5 Analyses & A-Train Observations

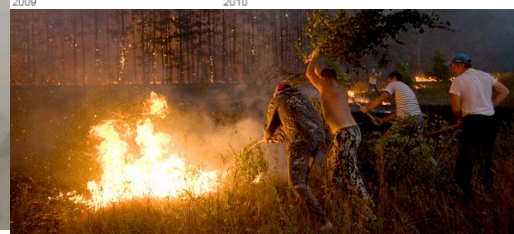
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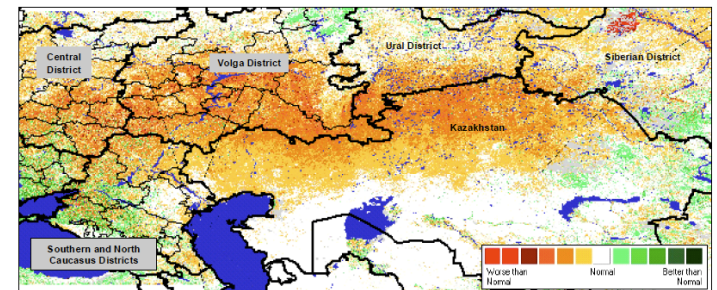
A-Train Symposium, New Orleans, LA: October 26, 2010



Wheat futures surge



MODIS NDVI: Departure from Mean, July 11-27, 2010



Satellite-derived vegetative indices indicate that crop conditions are significantly worse than normal in nearly every major crop-production region of Russia and Kazakhstan. Persistent drought and excessive heat have reduced yield prospects for all crops.



# Loosely Ordered Themes

- A brief overview of GEOS-5
- Meteorological anomalies (in GEOS-5/MERRA)
- CO distributions in the Moscow region -  
GEOS-5, MODIS and AIRS
- What we learned about “operational” GEOS-5
- Summary

# GEOS-5: A NASA Modeling & Assimilation System

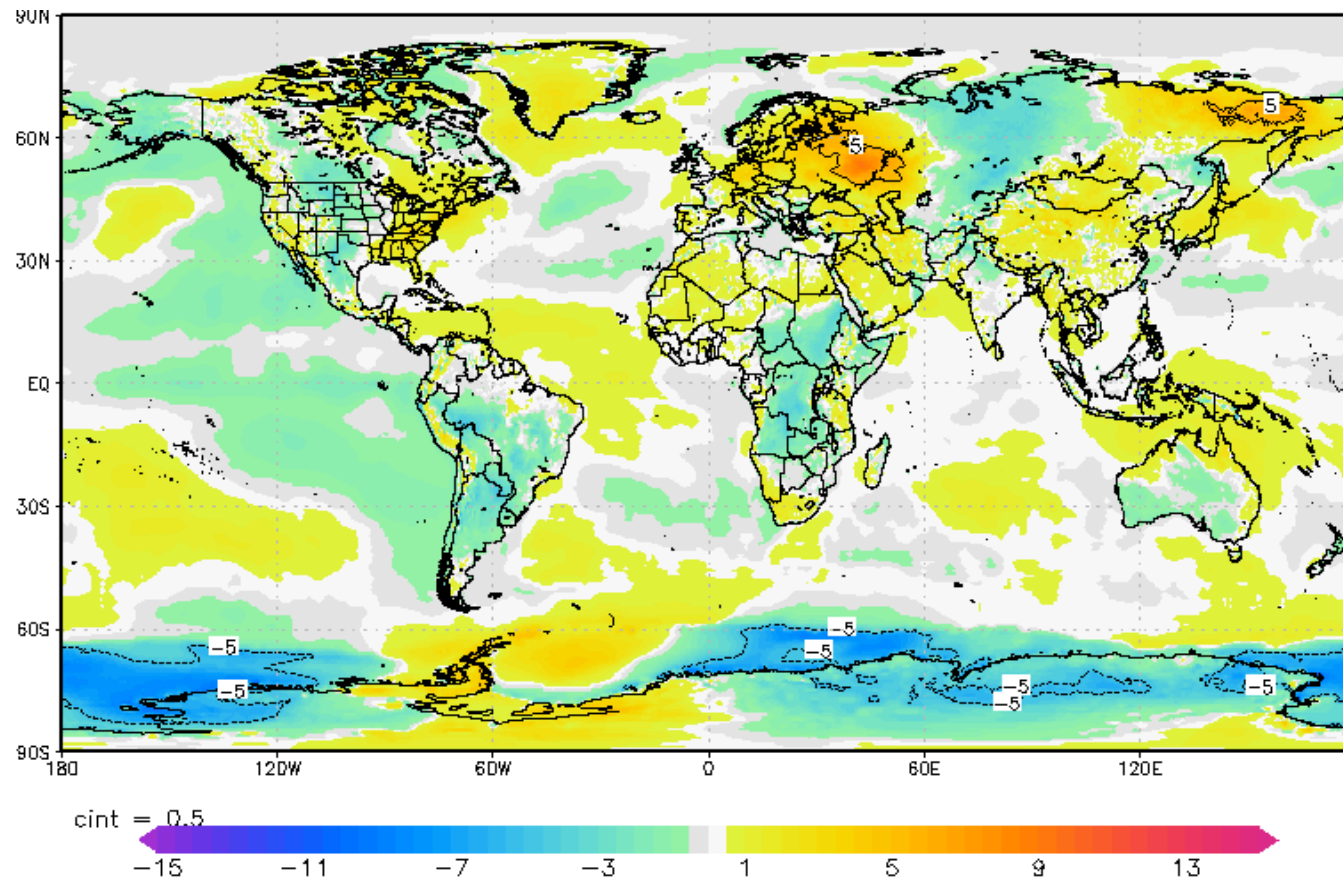
Versatile - towards Integrated Earth System Analysis

Includes components for aerosols and chemical species

Used today:

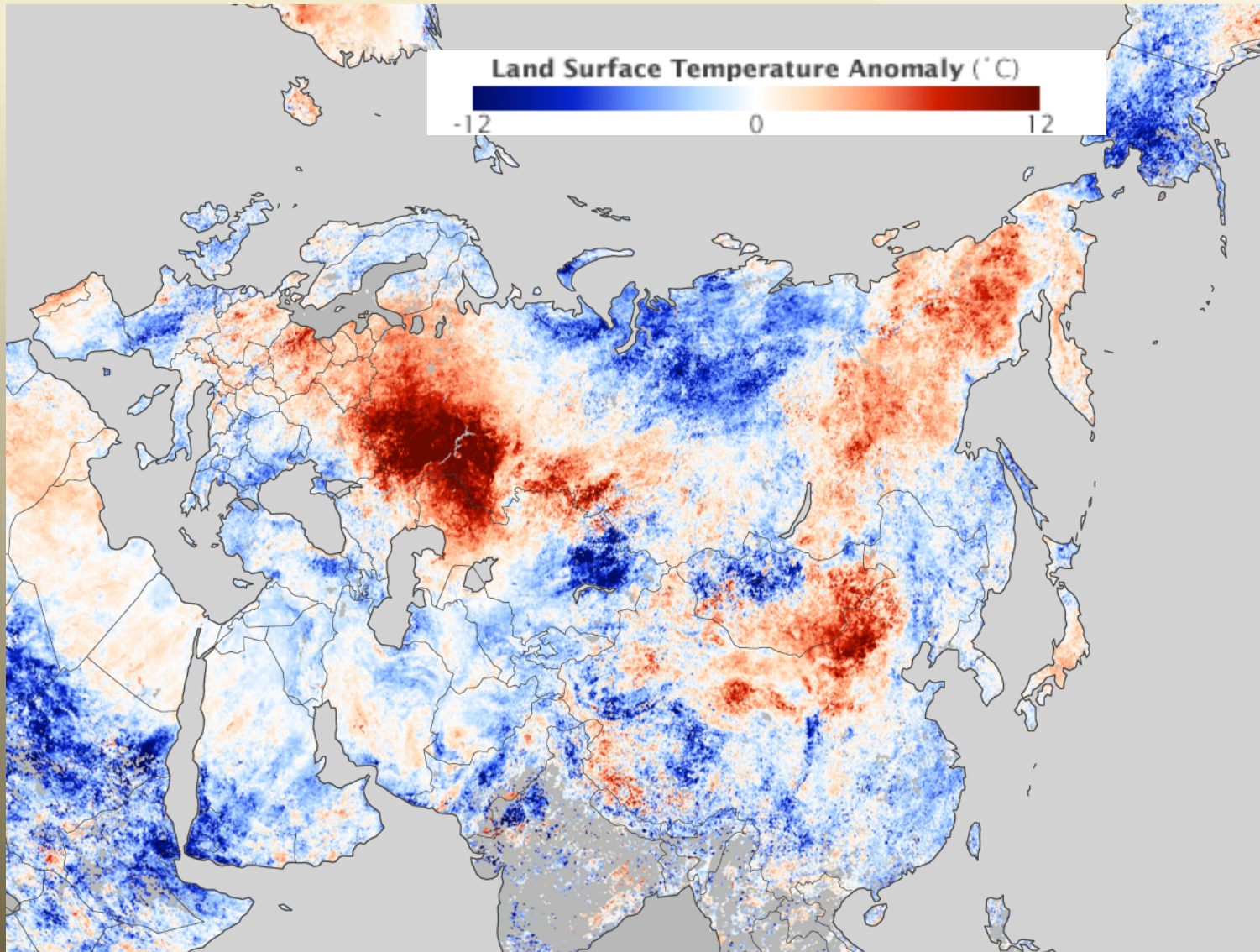
- MERRA meteorological analyses for 1979-2010 with GEOS-5.2.0 ( $0.5^\circ$ )
- Meteorological analyses for 2010, using GEOS-5.4.0 ( $0.25^\circ$ ), with emissions and transport CO of constituents:
  - Aerosols: GOCART modules
  - CO: linearized chemistry (specified OH)
  - Biomass-burning sources based on MODIS fire counts

## July 2010: 2-m (near-surface) Temp. Anomaly

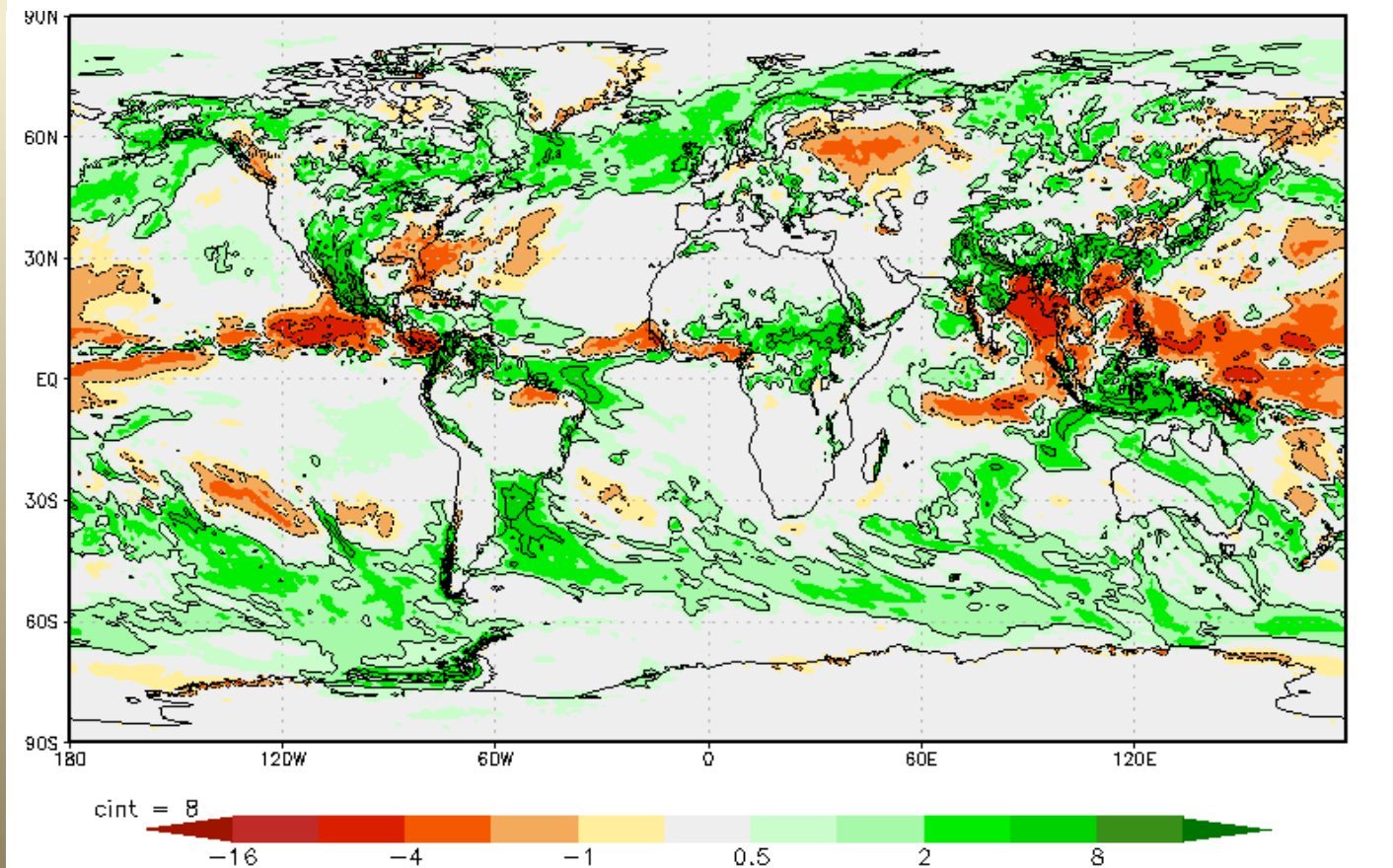


Extremely high and persistent surface temperature anomalies over western Russia (and eastern Siberia). The anomaly is the departure from the 1980-2009 (30-year) average in the GEOS-5/MERRA analysis.

2010 Surface Temp. Anomaly: July 20-27, 2010, relative to 2000-2008 average  
Computed from MODIS observations: <http://earthobservatory.nasa.gov/>



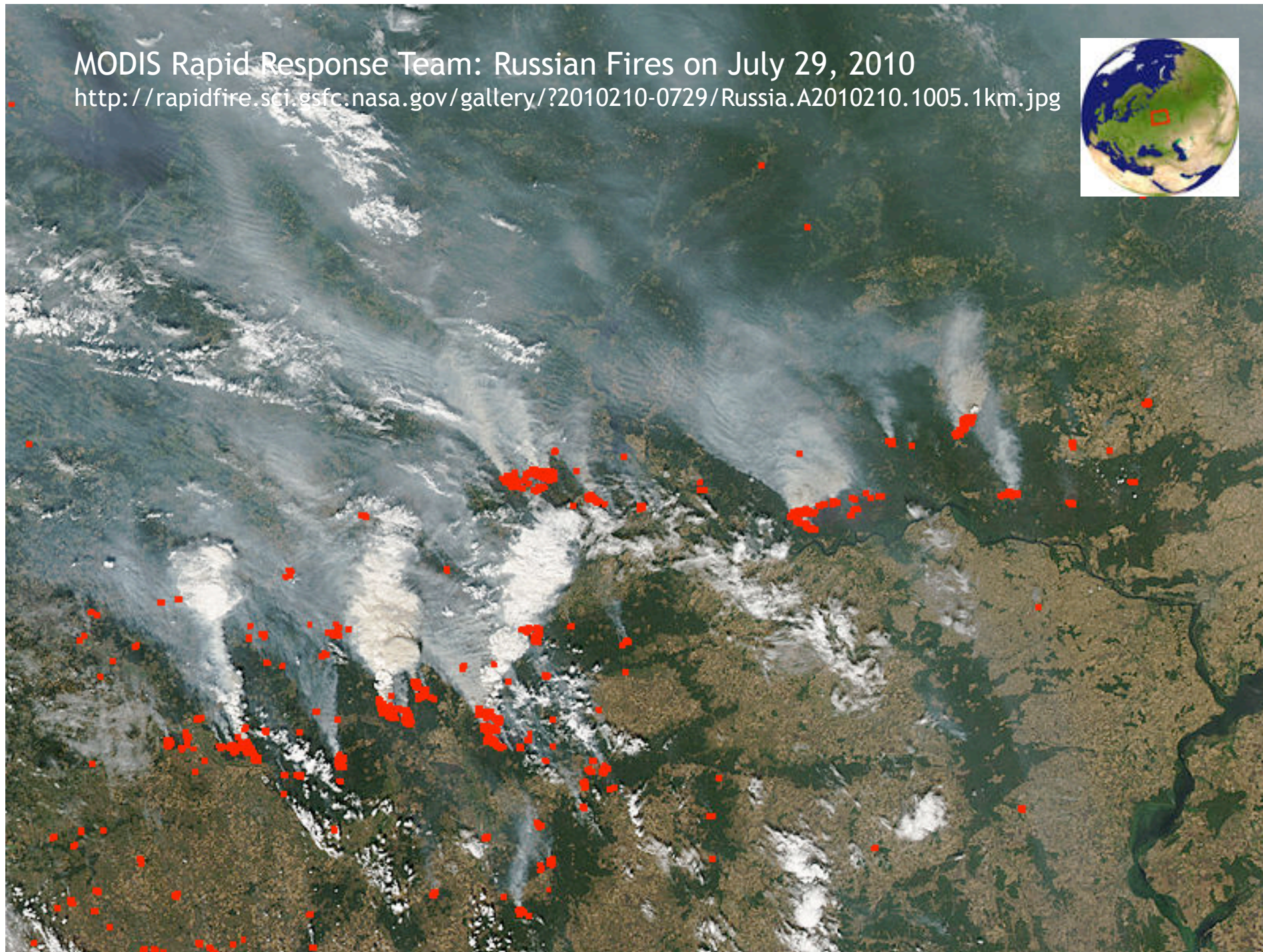
## July 2010: MERRA Precipitation Anomaly



Extremely strong precipitation anomaly over western Russia (and eastern Siberia). The persistent heat and drought led to severe agricultural disruption and set up the arid conditions conducive to fires

# MODIS Rapid Response Team: Russian Fires on July 29, 2010

<http://rapidfire.sci.gsfc.nasa.gov/gallery/?2010210-0729/Russia.A2010210.1005.1km.jpg>



## CO representation (in GEOS-5.4.0)

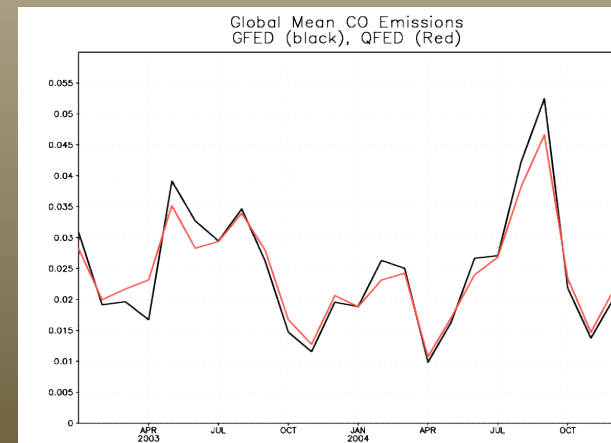
Chemical loss: prescribed 3D OH distribution and loss-rate constants

Emission inventories for fossil-fuel, bio-fuel, etc.  
(conversion included from methane, isoprene, methanol, terpenes, biogenic NMHCs)

Biomass-burning emissions derived from MODIS fire-count:

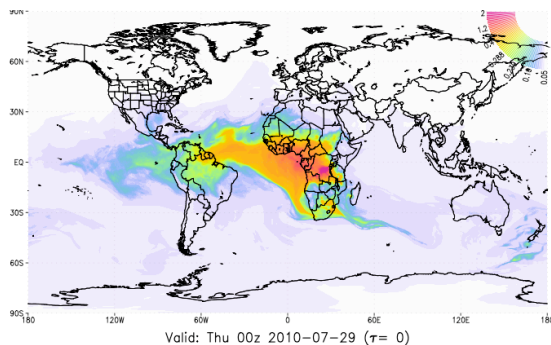
$$\text{CO emission} = \text{const}(\text{lat}, \text{lon}) \times f_c(\text{lat}, \text{lon}, \text{time})$$

QFED-1: Spatial values of constant emissions factor are tuned to ensure that global CO emissions by biomass burning are tuned to GFED-2 emissions

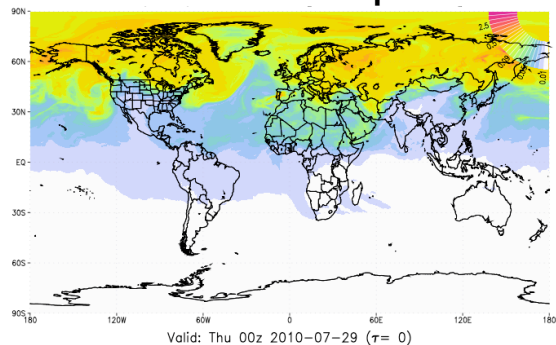


## Contributions to total CO column ( $10^{18}$ molecules $\text{cm}^{-2}$ ): July 29, 2010

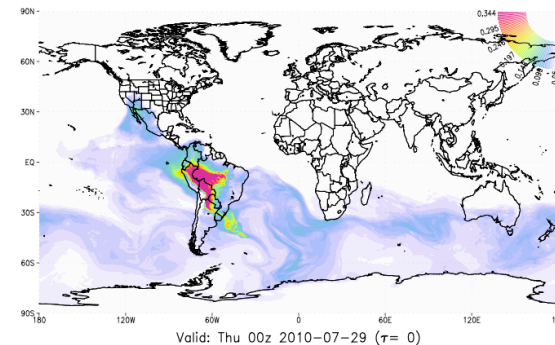
### African



### Asian & European



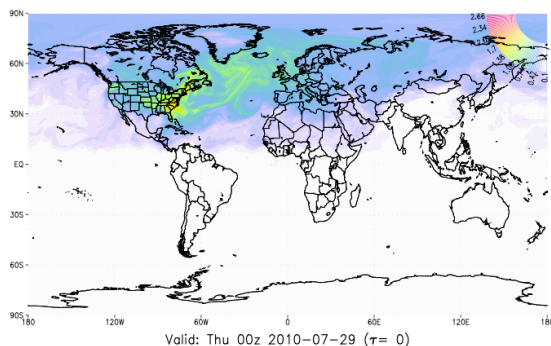
### South American



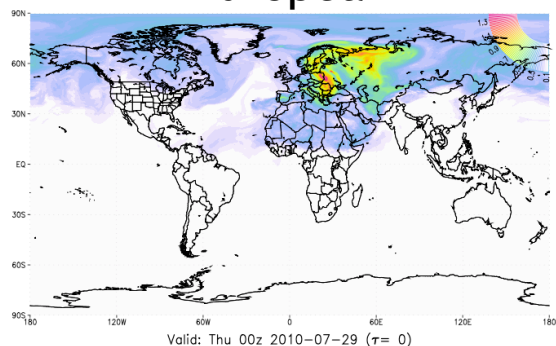
From regional biomass burning sources

From regional fossil fuel sources

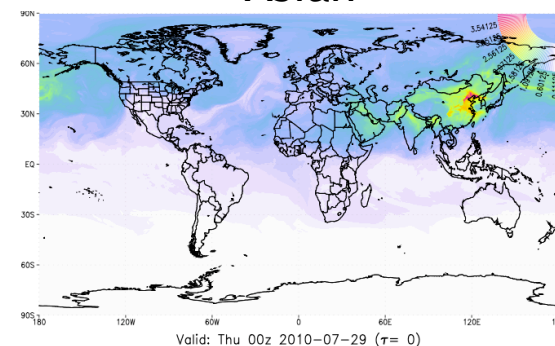
### North American



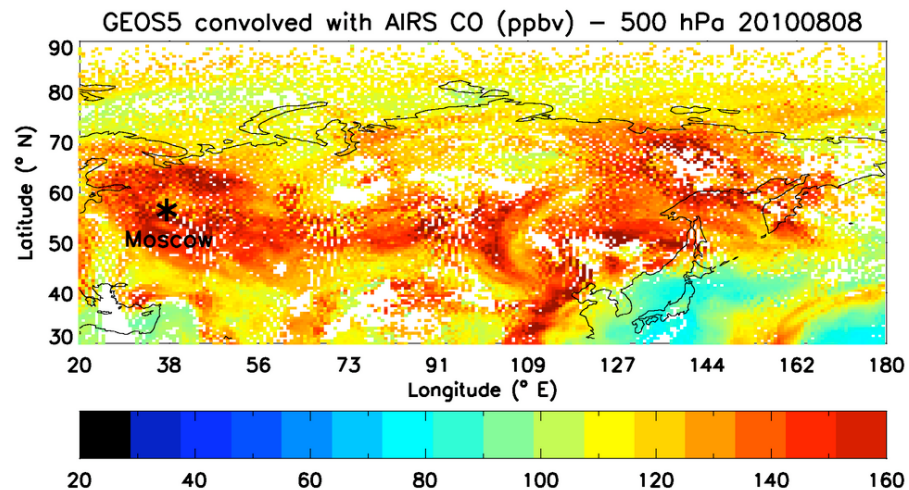
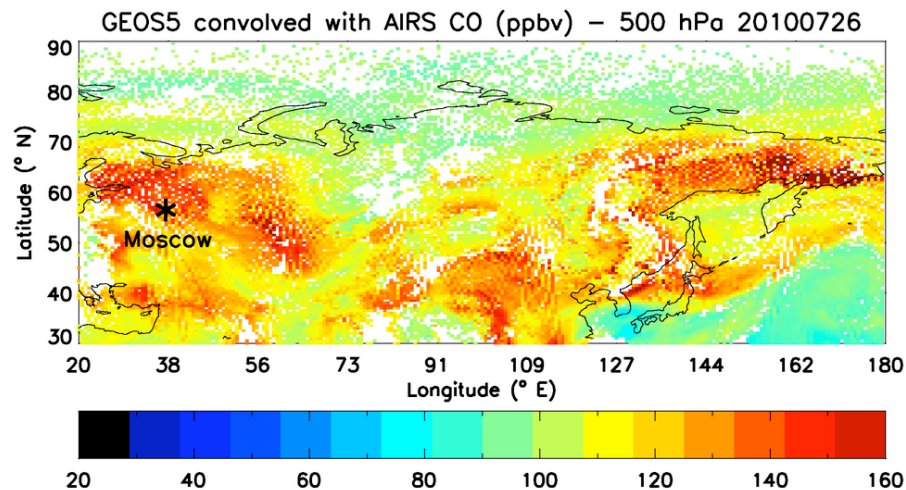
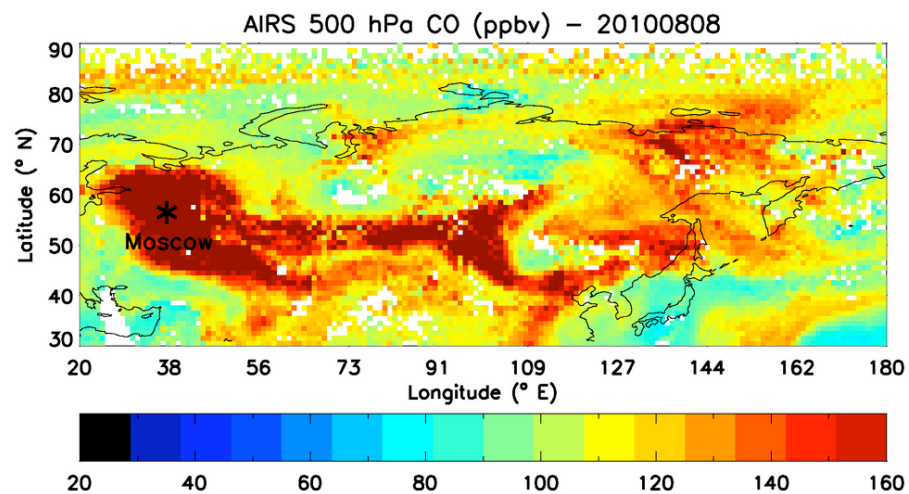
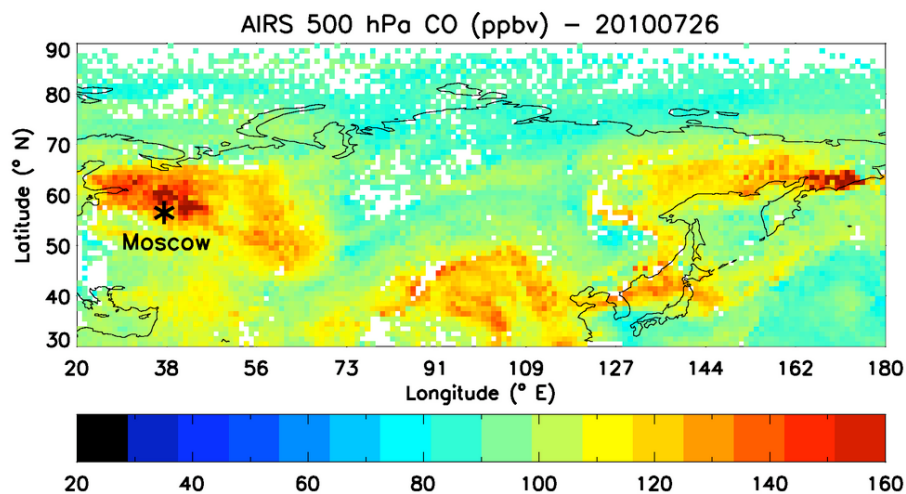
### European



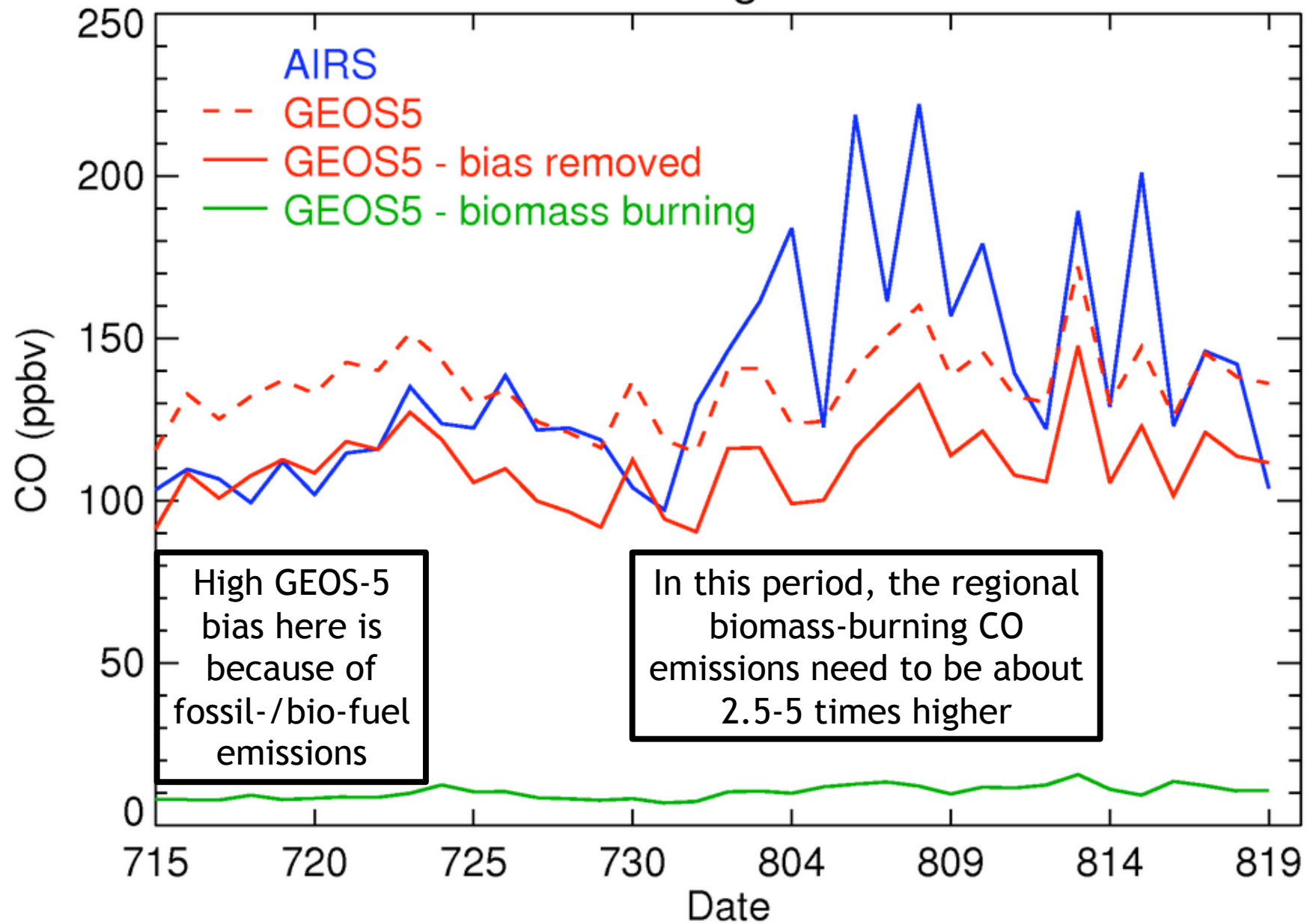
### Asian



## CO over Russia in July-August 2010: Evaluation of GEOS-5 Using AIRS



## Moscow CO mixing ratios - 500 hPa



# Emissions of CO

## High bias in background (pre-fire) CO:

- European fossil-fuel emissions in GEOS-5 have not been reduced from 2000-2005 values (not the case in research versions)
- Biogenic conversion factors are larger than the Duncan et al. (2007) recommendations (we use lower values in our research systems than in this production system)

## Biomass-burning emissions are underestimated:

- Scaling constants too small in Moscow region (e.g., no precedent in GFED)
- Burning regions obscured by smoke - fires not detected
- No persistence of fires beyond day of observation
- Much of the burning was peat fires - hard to detect AND high CO emissions AND persistent

# Summary

- The circulation anomalies associated with the “Moscow fires” in 2010 are well captured in GEOS-5
- Patterns of GEOS-5 CO distributions agree quite well with AIRS observations
- CO concentration biases relate to emissions:
  - Biomass burning - testing new components to add persistence to fires and peat burning
  - European background emissions (fossil fuel, etc.) are too high over Europe in “operational” GEOS-5 products



Smoldering Peat in Russia - August 2, 2010  
Photo Credit: Artyom Korotsyev, AFP/Getty Images